SARscape 5.7.0 Functional Summary

System configuration

Minimum recommended

ENVI 5.6.0 8 GB of RAM A CPU with at least 4 cores and an OpenCL 1.2-compatible device (either CPU or GPU) with double precision floating point (FP64) support.

Please note that the annotations are supported with with ENVI 5.6.2 or higher.

Ideal

ENVI 5.7.0 16/32 GB of RAM A CPU with 6+ cores and an OpenCL 1.2-compatible GPU with 8 GB of memory and double precision floating point (FP64) support, and a fast 512/1024 GB SSD disk

Operating system requirements

- Windows 10 64bit
- Linux 64bit (kernel 3.10.0 or higher, glibc 2.17 or higher)

Supported data

Airborne SAR Data:

- Astrium airborne SAR
- OrbiSAR-1-Amplitude
- OrbiSAR-1-SLC
- TELAER
- E-SAR
- F-SAR
- UAVSAR

SAR spaceborne

- ALOSPALSAR-1
- ALOSPALSAR-2
- ALOSPALSAR-1KC
- ALOSPALSAR-2KC
- ALOSPALSAR-1Geogrid
- ASNARO-2
- CSG
- CAPELLA
- COSMO-SkyMed
- ENVISAT ASAR
- ENVISAT MERIS
- EOS-04
- ERS SAR
- GAOFEN-3
- JERS-1 SAR
- KOMPSAT-5
- ICEYE
- LuTan-1
- NovaSAR
- PAZ-1
- RADARSAT-1
- RADARSAT-2
- RCM (Radarsat Constellation Mission)
- RISAT-1
- SAOCOM-1
- Sentinel-1
- Spacety
- Synspective
- SV-2
- TerraSAR-X and Tandem-X
- QPS
- UMBRA SICD

Other

- AIS
- ECMWF download
- ECMWF ERA 5download
- GACOS
- SICD and SICD in Polar Format
- SAR open street map
- Sentinel-2 download
- Sentinel-1 MultiDownload
- Sentinel download auxiliary file
- Tide height download
- Capella Archive Download
- Original ENVI format
- Tiff
- Binary format
- KML,KMZ
- Binary geocoded format

Vector Formats

- ESRI shape (.shp)
- GPS data can be ingested and used as input for any processing where GCP files are needed in SINEX or GSI format

Common Functions

Available when at least one module is licensed

Batch Processing

- Parameters editing
- Processing steps de-selection
- Error notification removal

Data Import

- Precise orbits and calibration parameters can be manually inputted or automatically retrieved from a predefined working folder

Preferences

- Several data-specific settings (general, ultra-very high resolution , very high resolution, high resolution, medium resolution, interferometry low coherence, wrong orbital data, ERS-ASAR interferometry, etc.) are provided with the original SARscape package
- Additional user-specific settings can be stored and applied in the actual data processing
- The parameters are grouped depending on the specific processing module and functionalities
- The Annotations tool enables to activate the annotations in ENVI View of the geocoded files

Administration

- Batch processing (store-edit-run processing chain)
- Clean working directory
- Save error report
- View files
    - Log file
    - Trace file
    - Header file
    - OpenCL Info
- Diagnostics
    - Check OpenCL configuration
    - Check cluster configuration
    - Open cluster monitor

- Cluster Diagnostic

General Tools

- Cartographic transformation:
  - raster images (change carto system and image grid size)
  - vector files
  - single point and point list
- Geoidal component addition and subtraction to/from a DEM
- DEM extraction (automatic download and mosaic)
  - GLAS-ICESat
  - RAMP
  - SRTM-3 Version2
  - SRTM-3 Version4
  - SRTM-1 Version3
  - ALOS World3D 30m
  - TDM90
  - DTED
  - GMTED-2010
- DEM fusion
  - DEM fusion weighted average
  - Wavelet combination DEM (low pass-high pass component cross combination)
  - Point cloud DEM fusion
- Data transformation
  - Conversion complex to phase-module
  - Conversion phase-module to complex
  - Conversion DEM to slope and Slope
  - Transform raster data
  - Image interpolation (image voids filling) bilinear and relax (large voids DEM dedicated algorithm).
- GPS time series manipulation
  - filtering
  - linear fitting
  - under-sampling
  - reprojection along satellite line of sight (LOS)
- Data Export
  - Generate color composite (standard, dual-polarization, interferometric)
  - Generate google earth KML File
  - Generate quick look (tiff and png)
  - Generate SIDD
  - EnviSeries to NetCDF
- Mosaicking
  - Conventional mosaicking
    - Last pixel overlay
    - Mean
    - Feathering
    - Based on precision and resolution layers (interferometric products)
  - Gradient method for seamless mosaics with absolute and local calibration along overlap edges cut lines
  - Slant-range geometry mosaicking
  - Mosaic Sentinel-1
- Annotations
  - Generate Annotations Raster
  - Generate Annotations Ships
- Orbital correction
  - Automatic orbital correction using a reference DEM
  - Manual orbital correction using GCP
  - Pulse repetition frequency (PRF) correction using GCP
  - Automatic update to precise orbits
    - DEOS
    - DORIS
    - PRC/PRL
    - RADARSAT-2
    - SENTINEL-1
- Data and quality analysis
  - DEM validation
  - Doppler estimation from raw or SLC data
  - Point target analysis (signal response of point targets/corner reflectors)
  - SAR dedicated data statistics
  - Radio frequency interference raw and SLC image filter
- Data subset (co-ordinate based or common area based)
  - Slant-range geometry data
  - Geographic geometry data
  - Maximum Common Area
  - Shape tiler
- Time series analyzer
  - Raster
  - Vector
  - Coherence Matrix Viewer
- Generate ground control point file (GCP)
- Point Gridding (DEM point cloud to raster)
- SARscape Task-IDL scripting-Modeler
  - IDL API for scripting (IDL is mandatory)
  - SARscape modeler
  - SARscape task (IDL is mandatory)

Output Formats

- SARscape specific
- ENVI
- Google Earth KML file
- TIFF, geoTIFF
- ESRI Shape (.shp)

Display Functions

- Displacement history (shape & raster format)
- Amplitude history (shape & raster format)
- Polarimetric signature
- SBAS & PS connection graph
- *Selectable regions of interest*
- ESRI shape (.shp)
- ENVI vector (.evf)
- Map coordinates
- ENVI ROI
- Ship Statistics

Modules

Basic Module

Provided with the Basic module license

Automatic workflows

- Coherence workflow (ILU RGB, CCD, MTC RGB, MICCD RGB, COV-PWR-CC RGB, CCD timeline, CCD timeline & PWR)
- Intensity time series
- Intensity single image
- Moving target detection

- Data multi-looking in time and frequency domain.
- Data co-registration (polynomial and topography dependent registration)
- Single date filters:
  - Mean
  - Median
  - Mode
  - Edge preserving smoothing
  - Frost
  - Lee
  - Refined lee
  - Anisotropic non-linear diffusion
  - Adaptive non-local SAR
- Data geocoding using the range-doppler approach:
  - Optional input DEM
  - Optional radiometric calibration
  - Optional radiometric normalization
  - Different calibration and normalization Methods
  - Output sigma nought, gamma nought and beta nought
  - Output in linear or decibel values
  - Optional input GCP
  - Optional optimal resolution approach
  - Transformation of geocoded data into SAR geometry (raster, vector, and point data)
  - Layover and shadow map and local incidence angle map
- Multi-temporal Filters:
  - De Grandi
  - Filtering multi-temporal ANLD
- Feature Extraction:
  - Interferometric coherence
    - Boxcar method
    - Adaptive non-local InSAR method
  - Coefficient of variation
  - Image ratios
  - Multi-temporal features (mean, minimum, maximum, mode, median, standard deviation, gradient, span, increment, decrement, minimum and maximum ratios)
  - Moving target detection
  - Enhanced DPSVI
  - Ship detection and statistic
  - SAR-AIS (automatic identification system) matching
  - Coastline Extraction
- Post calibration corrections:
  - Range normalization anomalies
  - Absolute offsets
  - Dielectric constant anomalies

Focusing Module

The Basic or the Interferometry module is mandatory.

ERS or ENVISAT ASAR IM consecutive scenes acquired along the same orbit can be mosaicked before the focusing takes place.

- ALOS PALSAR RAW Data:
  - Zero doppler (ERSDAC-like) and non-zero doppler (JAXA-like) FBS, FBD and PLR products are supported
- ENVISAT ASAR RAW Data:
  - AP, IM and WS products
  - Possibility to focus a portion of the input data
- ERS-1&2 RAW:
  - CEOS or ENVISAT format data are supported
- JERS-1 RAW Data
- Sentinel-1

Gamma&Gaussian Filtering Module

The Basic module is mandatory.

The implemented algorithms allow choosing among different filtering approaches depending on the spatial and spectral characteristics of the input data.

- Single look complex:
  - Gaussian DEMAP
  - Gaussian gamma MAP
  - SLC gaussian DEMAP
- Single channel detected (intensity image):
  - Gamma APM
  - Gamma MAP
  - Gamma DEMAP
- Multi-channel detected (intensity stack):
  - Gamma Gaussian MAP
  - Gaussian Gaussian MAP
  - Gaussian DE MAP
- Polarimetric
  - Wishart gamma MAP
  - Wishart gamma DE MAP

Interferometry Module

Provided with the Interferometry module license

Phase processing

Interferometric pair phase processing for coherence change detection, DEM and displacement map generation.

- Data co-registration (polynomial and topography dependent registration)
- Co-registered results available as either multi-looked intensity or Single Look Complex data
- Interferogram generation:
  - Spectral shift filter (optional)
  - Doppler filter (optional)
  - Selectable multi-looking for the output products
- Interferogram flattening:
  - Optional Input DEM
  - Optional Input GCP
- Interferogram filtering and coherence generation:
  - Goldstein method
  - Boxcar method
  - Spatial adaptive method
  - Adaptive Non-Local InSAR method

- Interferometric coherence generation (either from the filtered or from the unfiltered interferogram)
- Phase unwrapping:
    - Region growing method
    - Minimum cost flow (MCF) method (square grid)
    - Delaunay minimum cost flow method (triangular grid)
- Orbital refinement
    - GCP based correction of the orbits
    - Polynomial phase correction
- Re-flattening with removal of orbital fringes and phase offset
- Phase to height conversion and geocoding
- Phase to displacement conversion and geocoding

Stereo Radargrammetry

Intensity stereo pair processing for DEM generation

- Data co-registration (polynomial and topography dependent registration)
- Stereo matching process
- Orbital refinement
    - GCP based correction of the orbits
    - Polynomial phase correction
- Re-flattening with removal of orbital fringes and phase offset
- Shift to height conversion and geocoding

MAI Processing

Interferometric pair azimuthal phase processing to estimate large (but smaller than the sensor ground resolution) land displacements along azimuth (almost north-south) direction

- Data co-registration (polynomial and topography dependent registration)
- LOS and azimuthal interferogram generation
- Orbital refinement
    - GCP based correction of the orbits
    - Polynomial phase correction
- Re-flattening with removal of orbital fringes and phase offset
- LOS and azimuthal phase to LOS and azimuthal displacement conversion and geocoding

Amplitude tracking

Intensity pair processing to estimate very large (with respect to the sensor ground resolution) land displacements along line of sight and azimuth (almost north-south) direction

- Data co-registration (polynomial and topography dependent registration)
- LOS and azimuthal interferogram generation
- Orbital refinement
    - GCP based correction of the orbits
    - Polynomial phase correction
- Re-flattening with removal of orbital fringes and phase offset
- LOS and azimuthal shift to LOS and azimuthal displacement conversion and geocoding

Three-pass and Four-pass Differential Interferometry

- Linear model for “subsidence-like” displacements
- Step model for “earthquake-like” displacements
- No model when the first pair is not affected by any displacement
- Generation of slant range and geocoded products

Displacement Modeling

- Displacement Modeling
    - Non-linear and linear inversion
    - CFF stress transfer
    - Forward modeling
- Displacement modeling tools
    - Create source shapefile
    - Image subsampling
    - Import USGS slip distribution and initialize values from CMT catalogue
    - Calculate and draw focal mechanism
    - Project raster to LOS
- Input geodetic datasets
    - DInSAR dataset
    - GPS dataset
- Geophysical sources
    - Elastic dislocation (Okada)
    - Point pressure (Mogi)

Automatic workflows

- Coherence workflow (ILU RGB, MTC RGB, MICCD RGB, CCD, CCD stack timeline)
- Moving target detection
- InSAR DEM generation
- Stereo radargrammetry DEM generation
- Displacement generation along the line of sight or reprojected along the known direction
- Multi aperture interferometry (MAI) displacement generation
- Amplitude, offset tracking

Cluster

- CCD Cluster (Coherence Change Detection geocoded map generation in cluster mode)
    - Boxcar method
    - Adaptive non-local InSAR method
- Stereo Cluster (Stero-Radargrammetry DEM generation in cluster module)

Interferometric tools

- Baseline and orbital parameters estimation (with plot of theoretical height precision and theoretical displacement precision).
- Atmospheric phase delay correction of ENVISAT ASAR data using MERIS products (a dedicated interpolation method to replace cloudy pixels)
- Multi-looked complex data generation
- Interferometric data co-registration (to overlay interferometric products derived from different SAR pairs)
- Baseline calculation of a multitemporal series, to compute the baseline for all possible combinations in the input series
- Phase editing:
    - Automatic or semiautomatic estimate (and correction) of unwrapping errors due to phase jumps
    - Data masking
- Automatic removal of the residual phase. Optionally a GCP file can be used for the fringe pattern estimation
- Sample selection for interferometric multitemporal series
- Synthetic phase generation (synthetic phase and slant range DEM):
    - Optional Input DEM
    - Optional Input GCP

- Synthetic phase flattening, to calculate the differential phase from two input interferograms
- Displacement decomposition (2D-3D) obtained from multiple displacement acquisition geometries (ascending, descending, azimuthal) and techniques (DInSAR, MAI, amplitude tracking)

Interferometric Stacking Module

The Basic and the Interferometry modules are strongly suggested. In case of ScanSAR data such as Palsar2 ScanSAR and TSX-ScanSAR, the ScanSAR module is mandatory.

Persistent Scatterers (PS) available in cluster mode & Enanched-PS (E-PS) -

- Automatic or manual selection of the reference acquisition. The data related information is generated prior to the processing execution: measurement (displacement velocity, PS height) precision estimate, spatial and temporal baselines
- Flattened interferogram generation (for details refer to the Interferometry module) The input DEM is mandatory and input GCP is optional.
- First linear inversion to generate the intermediate residual topography and linear displacement average velocity.
- Second inversion to generate the precise residual topography, the average trend, and the time series over the user-defined coherence threshold identified PS. The atmospheric distortion is estimated and removed
- Generation of slant range and geocoded products in raster, shape and kml format. PS and DS (if E-PS is performed) associated information: date by date and total displacement, displacement velocity, corrected height, coherence value

Continuous Tomography

- Automatic or manual selection of the reference acquisition. The data related information is generated prior to the tomographic processing execution.
- Flattened interferogram generation (for details refer to the Interferometry module) The input DEM is mandatory and input GCP is optional.
- First linear inversion to generate the intermediate residual height.
- Second inversion to generate the tomographic layers; the atmospheric distortion is estimated and removed.
- Generation of geocoded tomogram layers and meta tomogram file.

Small Baseline (SBAS – disconnected blocks-SBAS) - available in cluster mode - & Enhanced-SBAS (E-SBAS)

- Connection graph, to define the data connection network based on spatial and temporal baseline constraints or the average number of linking interferogram per acquisition (average redundancy)
- Interferogram to phase unwrapping, from data co-registration to phase unwrapping (for details refer to the interferometry module). Input geophysical model can be ingested.
- First inversion step, to generate the intermediate displacement and height related products. Input geophysical models can be considered during the inversion. Disconnected blocks can be managed. Five different displacement models are available to generate:
  - average linear velocity displacement model
  - linear plus the quadratic acceleration displacement model
  - linear plus the quadratic plus cubic delta acceleration displacement model
  - linear plus the periodical displacement model
  - no displacement model: the SBAS is used to generate precise DEM only
- Second inversion step, to generate the time series estimation and perform the atmospheric corrections. Disconnected blocks (interrupted time series) can be managed.
- Geocoding of the SBAS products in LOS direction and optionally along the known re-projected user-defined direction. The product can be provided in raster (easily and faster managed by ENVI) and vector (shape with a precise geolocation) format.

Interferometric Stacking Module Tools

Provided with the Interferometric Stacking module license

- PS and SBAS edit connection graph, to modify the original connection graph. Remove or add (incremental processing) single images, or image pairs, from the original selection
- Plot viewer, to reload previously generated connection graphs.
- Time series Classificaion (shape and raster format), to plot and interpret the displacement history generated from the SBAS processing or PS. Spatial and temporal (disconnected blocks) interpolation can be highlighted.
- Raster and shape 2D time series decomposition from multiple geometries acquisition stack.
- Raster and shape time series merge from multiple sensors acquisition stack (with similar incidence angle).
- Tomographic Slice to generate vertical slices withing the tomogram.
- Time Series Analysis, to classify the displacement time series using external temporal phenomenological data or analytical displacement models.
- Skew Estimation, analyzes the velocities of a decomposed velocity layer from SBAS and PS.
- Shape Tiler, to cut one or multiple shapefiles into tiles of regular size and alignment.
- Point Density, to create density maps of the point shape files generated by the SBAS and PS processes.
- SBAS Variogram, this tool is used to evaluate the performance of the atmosphere removal algorithms within the SBAS processing chain. This tool perform a statistical comparison before and after the application of a specific atmosphere filter.
- Clustering, This tool is intended to cluster the deformation time series generated by PS or SBAS processes. It works by grouping nearby time series according to their similarity based on a modified DB Scan algorithm.

ScanSAR Interferometry Module

The ScaSAR Interferometry module is mandatory, to process Palsar2-Scansar (full aperture mode), TSX-Scansar data in interferometric mode. The sentinel 1 data can be processed by both: ScanSAR Interferometry module and Interferometry module.

Phase processing

Interferometric pair phase processing for coherence change detection, DEM and displacement map generation.

- Data co-registration (polynomial and topography dependent registration)
- Co-registered results available as either multi-looked intensity or Single Look Complex data
- Interferogram generation:
    - Spectral shift filter (optional)
    - Doppler filter (optional)
    - Selectable multi-looking for the output products
- Interferogram flattening:
    - Optional Input DEM
    - Optional Input GCP
- Interferogram filtering:
    - Goldstein Method
    - Boxcar Method
    - Adaptive Method
- Interferometric coherence generation (either from the filtered or from the unfiltered interferogram)
- Phase unwrapping:
    - Region growing method
    - Minimum cost flow (MCF) method (square grid)
    - Delaunay minimum cost flow method (triangular grid)
- Orbital refinement
    - GCP based correction of the orbits
    - Polynomial phase correction
- Re-Flattening with removal of orbital fringes and phase offset
- Phase to height conversion and geocoding
- Phase to displacement conversion and geocoding

Scansar Interferometric tools

- Automatic removal of the residual phase. Optionally a GCP file can be used for the fringe pattern estimation

Polarimetry and Polarimetric Interferometry

The Interferometry module is mandatory.

Polarimetry

- Polarimetric calibration matrix:
    - Possibility to remove the effect of a previous calibration
    - Possibility to use either the default or a user-specific calibration matrix in case of input data which are not calibrated
- Polarimetric signature:
    - The real as well as the theoretical signature is provided for point-target-like objects
    - The ellipticity as well as the orientation of the received wave can be modified
- Polarimetric features, to generate one or more polarimetric intensity combinations. Selectable multi-looking for the output products
- Polarization synthesis, to create a new synthetic polarimetric set in one of the following orthogonal bases:
    - Circular
    - Linear rotated of 45°
    - Elliptical (orientation and ellipticity defined by the user)
- Pauli Decomposition, to discriminate elementary targets using a coherent approach
- Entropy alpha-anisotropy decomposition, to discriminate complex targets using an incoherent approach. Selectable filter type and window size
- Dual Polarimetric Entropy Alpha Anisotropy Decomposition for coherency matrix of dual-polarimetric SLC
- Entropy alpha-anisotropy unsupervised classification

Polarimetric interferometry

- Co-registration (polynomial and topography dependent registration)
- Synthetic phase generation: optional input DEM, optional input GCP
- Coherence optimization, to generate the three optimal flattened interferograms and coherences (minimum, medium and maximum) from a polarimetric interferometric pair. Selectable filter type and window size. Selectable multi-looking for the output products
- Polarimetric phase difference, to generate the Interferogram from two polarizations of the same acquisition. Selectable multi-looking for the output products
- Interferogram generation, to generate either the Interferogram from the same polarization of two different acquisitions. Selectable multi-looking for the output products
- Synthetic phase flattening, to flatten an interferogram using a previously generated synthetic phase
- Synthetic phase flattening, to calculate the differential phase from two input interferograms
- Coherence, to generate the coherence from either a polarimetric phase difference or an interferogram

Documentation

- Online user's guide
- Hyperlinked help documentation
- Module specific test data sets
- PS tutorial
- SBAS tutorial
- Displacement modeling tutorial
-